

**What is claimed is:**

1       A reception determination method of a ray, in which a  
path of a ray provided within an observation region is  
5       predicted, and reception determination processing is  
applied to reception points of said ray, which are  
arranged in advance within said observation region,

characterized in that the reception points arranged  
within said observation region are divided into groups for  
10       singular or plural reception points, and said reception  
determination processing is applied to reception point  
groups including the reception points to which said  
reception determination processing is needed to be applied.

15       2       A reception determination method of a ray recited in  
claim 1, characterized in that hierarchical grouping  
processing is applied to said reception points so that a  
structure in which a reception point group having a large  
scale involves a smaller scale of plural reception point  
20       groups is formed, and hierarchical structure information  
constructed of information with respect to an implication  
relationship of the reception point groups between  
different hierarchies and the reception points included in  
the reception point groups is constructed.

3        A reception determination method of a ray recited in  
claim 1, characterized in that screening processing for  
leaving only said reception point groups including the  
reception points inside, to which said reception  
5        determination processing is need to be applied, is applied  
to said reception point groups inside said observation  
region, and said reception determination processing of the  
ray and the reception points is applied to only the  
reception points included in said finally screened  
10        reception point groups.

4        A reception determination method of a ray recited in  
claim 3, characterized in that, referring to said  
hierarchical structure information, said screening  
15        processing is conducted stepwise by means of a successive  
transition from a large scale of the reception point group  
to a small scale of the reception point group.

5        A reception determination method of a ray recited in  
20        claim 3, characterized in that the screening determination  
for said screening processing is conducted by means of  
intersection determination of a region where the reception  
point groups are involved and a partial space which is  
defined in the vicinity of said ray.

6        A reception determination method of a ray recited in  
claim 3, characterized in that, in the screening  
determination for said screening processing, said  
screening determination is successively applied to each  
5        reception point group until it is finished to the  
reception point groups belonging to the same hierarchy  
within said observation region, and thereafter, the  
processing is moved to the next hierarchy consisting of a  
smaller scale of reception point groups, and similarly,  
10        said screening processing is applied to each reception  
point group until it is finished to the reception point  
groups which would be a subject of said screening  
determination inside the same hierarchy.

15        7        A reception determination method of a ray recited in  
claim 3, characterized in that, in the screening  
determination for said screening processing, said  
screening determination processing is applied to one of  
the reception point groups within said observation region,  
20        and then, a smaller scale of one reception point group  
involved in said reception point groups is selected from  
the next hierarchy of a hierarchy to which said reception  
point groups belong to apply said screening determination  
thereto, and at a step when arriving at a hierarchy of  
25        reception point groups which cannot be finally divided,

said reception determination processing of the ray and the reception points is applied to reception points involved in said reception point groups, and thereafter, said screening determination is applied to non-selected reception point groups in a one-stage upper hierarchy, and whereby said screening determination processing is recursively operated.

**8** A reception determination method of a ray recited in claim 3, characterized in that, as the region involving said reception point groups, a circumscribed sphere circumscribed with these reception point groups is utilized.

**9** A reception determination method of a ray recited in claim 3, characterized in that, as the region involving said reception point groups, a region defined by a combination of regions divided by singular or plural planes is used.

**10** A reception determination method of a ray recited in claim 8, characterized in that said reception points are arranged in the shape of a planar lattice in said observation region, and in said hierarchical grouping processing, when lattice points which stand in a line on a

most outer side form a rectangle, the number of the  
reception points (most external contour reception points,  
hereinafter) which stand in a line on two sides thereof is  
resolved into a sum of  $a^n$  ( $a$  is an integer equal to or  
5 more than 1, and  $n$  is a positive integer including 0), and  
after square regions in which each factor of the generated  
 $a^n$  by means of the resolution is assumed to be the number  
of the most external contour reception points are newly  
generated, out of these square regions, the regions having  
10 a greater area are spread inside said observation region  
as much as possible, and further, by successively dividing  
each of the spread square regions into  $a^2$  square regions  
having the same area, a hierarchical group of the  
reception points is structured.

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**11** A reception determination method of a ray recited  
in claim 5, characterized in that, in case that a barrier  
is positioned at both ends of said ray, said screening  
determination is conducted by means of the intersection  
20 determination of a region sandwiched between two planes  
including the barrier, and said reception point groups.

**12** A reception determination method of a ray recited  
in claim 5, characterized in that, when it is determined  
25 whether or not said reception point groups are divided

into a smaller scale of reception point groups, said screening determination is conducted by using a value of a cost function defined in advance.

5       **13**       A radio wave propagation characteristic estimation method characterized in that estimation of radio wave propagation in said observation region is made by using the reception determination method of a ray recited in claim 1.

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**14**       A reception determination system of a ray, in which a path of a ray provided within an observation region is predicted, and reception determination processing is applied to reception points of said ray, which are arranged in advance within said observation region,  
15               said reception determination system comprises:

              grouping means for grouping the reception points arranged within said observation region for singular or plural reception points; and

20               reception determination means for applying said reception determination processing to reception point groups including the reception points to which said reception determination processing is needed to be applied.

25       **15**       A reception determination system of a ray recited

in claim 14, wherein said grouping means applies hierarchical grouping processing to said reception points so that a structure in which a reception point group having a large scale involves a smaller scale of plural reception point groups is formed, and constructs hierarchical structure information constructed of information with respect to an implication relationship of the reception point groups between different hierarchies and the reception points included in the reception point groups.

**16** A reception determination system of a ray recited in claim 14, further comprises screening means for applying screening processing for leaving only said reception point groups including the reception points inside, to which said reception determination processing is need to be applied, to said reception point groups inside said observation region, and

said reception determination means applies said reception determination processing of the ray and the reception points to only the reception points included in said finally screened reception point groups.

**17** A reception determination system of a ray recited in claim 16, based on said hierarchical structure

information, said screening means conducts said screening processing stepwise by means of a successive transition from a large scale of the reception point group to a small scale of the reception point group.

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**18** A reception determination system of a ray recited in claim 16, wherein said screening means conducts the screening determination for said screening processing by means of intersection determination of a region where the reception point groups are involved and a partial space which is defined in the vicinity of said ray.

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**19** A reception determination system of a ray recited in claim 16, wherein said screening means successively applies the screening determination for said screening processing to each reception point group until it is finished to the reception point groups belonging to the same hierarchy within said observation region, and thereafter, moves to the next hierarchy consisting of a smaller scale of reception point groups, and similarly, applies said screening processing to each reception point group until it is finished to the reception point groups which would be a subject of said screening determination inside the same hierarchy.

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**20** A reception determination system of a ray recited  
in claim 16, wherein said screening determination means  
applies said screening determination processing to one of  
the reception point groups within said observation region,  
5 and then, selects a smaller scale of one reception point  
group involved in said reception point groups from the  
next hierarchy of a hierarchy to which said reception  
point groups belong to apply said screening determination  
thereto, and at a step when arriving at a hierarchy of  
10 reception point groups which cannot be finally divided,  
applies said reception determination processing of the ray  
and the reception points to reception points involved in  
said reception point groups, and thereafter, applies said  
screening determination to non-selected reception point  
15 groups in a one-stage upper hierarchy, and thereby,  
recursively operates said screening determination  
processing.

**21** A reception determination system of a ray recited  
20 in claims 17, characterized in that, as the region  
involving said reception point groups, a circumscribed  
sphere circumscribed with these reception point groups is  
utilized.

**22** A reception determination system of a ray recited  
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in claim 16, characterized in that, as the region involving said reception point groups, a region defined by a combination of regions divided by singular or plural planes is used.

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**23** A reception determination system of a ray recited in claim 21, characterized in that said reception points are arranged in the shape of a planar lattice in said observation region, and in said hierarchical grouping processing, when lattice points which stand in a line on a most outer side form a rectangle, the number of the reception points (most external contour reception points, hereinafter) which stand in a line on two sides thereof is resolved into a sum of  $a^n$  ( $a$  is an integer equal to or more than 1, and  $n$  is a positive integer including 0), and after square regions in which each factor of the generated  $a^n$  by means of the resolution is assumed to be the number of the most external contour reception points are newly generated, out of these square regions, the regions having a greater area are spread inside said observation region as much as possible, and further, by successively dividing each of the spread square regions into  $a^2$  square regions having the same area, a hierarchical group of said reception points is structured.

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**24** A reception determination system of a ray recited in claim 18, characterized in that, in case that a barrier is positioned at both ends of said ray, said screening determination is conducted by means of the intersection determination of a region sandwiched between two planes including the barrier, and said reception point groups.

**25** A reception determination system of a ray recited in claim 18, characterized in that, when it is determined whether or not said reception point groups are divided into a smaller scale of reception point groups, said screening determination is conducted by using a value of a cost function defined in advance.

**26** A radio wave propagation characteristic estimation system characterized in that estimation of radio wave propagation in said observation region is made by using the reception determination system of a ray recited in claim 14.

**27** A program for having a reception determination method of a ray executed by a computer, in which a path of a ray provided within an observation region is predicted, and reception determination processing is applied to reception points of said ray, which are arranged in

advance within said observation region,

the computer readable program being characterized in that the reception points arranged within said observation region are divided into groups for singular or plural reception points, and said reception determination processing is applied to reception point groups including the reception points to which said reception determination processing is needed to be applied.